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Assessment of natural radionuclide levels in some Nigerian made poultry feedstuff

V. I. Ageda[1*], E. E. Ike[2] and S. T. Temaugee[3]

[1]Department of Physical Sciences, University of Mkar, Mkar, Benue State, Nigeria.
[2]Department of Physics, University of Jos, Jos, Plateau State, Nigeria.
[3]Department of Physics, Federal College of Education, Kontagora, Niger State, Nigeria.

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This study investigated the radionuclide contents of naturally occurring radionuclides. Ten samples of some Nigerian made poultry feedstuff and supplements were collected and analysed using NaI(Tl) gamma(γ)-ray spectroscopy for an accumulated time of about 29000 s. The results revealed that activity concentration of primordial radionuclides ^{40}K, ^{226}Ra, and ^{232}Th for the samples ranged from 43.6 to 196.8 Bq/kg, 5.0 to 34.7 Bq/kg and 0.9 to 51.6 Bq/kg, respectively. The presence of anthropogenic radionuclides was not detected. The Nigerian poultry fodders were found to have relatively higher activities of ^{226}Ra and ^{232}Th compared to the activities reported for poultry feeds in other countries. However, the radionuclide concentrations are not alarming.

Key words: Natural radionuclides, activity concentration, poultry, feedstuff, gamma ray spectroscopy.

INTRODUCTION

Among Nigerians dwelling in rural areas, poultry meat and eggs are to some extent still considered luxury foods but in the urban areas, poultry is consumed more often due to the relatively higher income; availability of poultry meat either as fresh or frozen products, and the introduction of a chain of fast food outlets, whose recipes and menus are rich in chicken meat and eggs, is on the increase.

There has been a concern with radiation levels in food, because ingestion is one of the most common way radionuclides enter living organisms. These radionuclides find their way into the food chain from soil or air to plants, plant to animals/humans, or from other lower animals to humans.

Animal feeds are developed from an organic base (plants or animals) and are intended to provide the most complete nutrition possible (Filho et al., 2016). In an attempt to improve nutritional value of feedstuff, feed substances derived from the biota that contain some elevated levels of radionuclide activity may sometimes be added to poultry feeds. This may increase the radionuclide concentration in such feeds.

Many Nigerian made poultry feeds comprised soybean, maize, sodium chloride and a vitamin complex called "Premix Vitamínico Mineral" ("Vitamin Mineral Premix"), bone meal and fish meal. Thus, in these feed samples,

*Corresponding author. E-mail: iverenageda@gmail.com.

Table 1. Samples identity and collection locations.

S/N	Sample No.	Location	Brand type	Feed formula
1	Samp 1	Benue	Feed supplement	Lysine
2	Samp 2	Benue	Feed supplement	Layer premix
3	Samp 3	Benue	Feed supplement	Methyonine
4	Samp 4	Benue	Feed supplement	Limestone
5	Samp 5	Benue	Feed supplement	Broilers Premix
6	Samp 6	Kaduna	Compounded feed (Rebson feed)	Layer mash
7	Samp 7	Kaduna	Compounded feed(Rebson feed)	Finisher
8	Samp 8	Kaduna	Compounded feed (PLS)	Chick mash
9	Samp 9	Kaduna	Compounded feed (PLS)	Grower mash
10	Sale 10	Kaduna	Compounded feed (PLS)	Layer mash

one must account for the natural radioactivity present in maize, soybeans and all the other components like limestone, phosphate rock which is another raw material used for the production of the feed supplement (Casacuberta et al., 2010), which supplies calcium for domestic animals such as poultry.

The food chain extends to the uptake of these radionuclides by animals from the feedstuff they eat which is deposited in their tissue and finally consumed by human. Thus, as humans ingest both eggs and poultry meat, it is expedient to monitor the radiation levels in poultry feedstuff since a part of the amount of radionuclides in the feed which animals ingest could possibly be transferred to humans via the radionuclide pathway in the food chain (Mc Donald et al., 1999; Breuninger et al., 2002; Hernandez et al., 2004).

Therefore, every source of radionuclide that has an end effect on humans whether directly or indirectly needs to be checked to ensure that substances meant for public consumption have radioactivity levels As Low As Reasonably Achievable (ALARA).

Around the world, researches have reported natural radioactivity levels in poultry fodders. However, there has been little or no reports on the concentration of natural radionuclides in poultry feeds made in Nigeria. Thus, this present work assessed the amount of natural radionuclides in samples of Nigerian made poultry feedstuff and compared the measured values with feedstuff produced in other parts of the world.

MATERIALS AND METHODS

Ten samples of Nigerian made chicken feedstuff and supplements used for poultry feeds were collected, prepared and analysed. Samples were collected on the basis of production and consumption in Nigeria. Sample collection was done by interaction with farmers, milling (manufacturing) companies and a few samples directly purchased from the market. Table 1 shows the sample collections.

Sample preparation

Collected samples of Nigerian made poultry feeds were pulverized to 200-300 mesh size, with a blender and ceramic mortar, and then homogenized to fine powder with a 2 mm-mesh sieve and packed to fill cylindrical plastic containers with inner dimension of 7.2 cm diameter and 6 cm height. This satisfied the selected optimal sample container height (Ibeanu, 1999). Each container accommodated approximately 300 g of sample which were carefully sealed (using vaseline, candle wax and masking tape) to prevent radon escape and then stored for a minimum of 28 days. This is to allow Radium and Thorium attain secular equilibrium with their (daughters) progenies.

Sample analysis

Gamma ray spectrometry technique was employed in the spectral collection of the prepared samples using the higher energy region of the γ-line. A 7.62 × 7.62 cm NaI(Tl) detector by Canberra Inc, housed in a 6 cm thick lead shield and lined with cadmium and copper sheets was used. A computer based Multichannel Analyzer (MCA) MAESTRO programme from ORTEC was used for data acquisition and analysis of gamma spectra. The energy calibration of the spectrometer was performed using certified reference material for radiometric measurement from the International Atomic Energy Agency (IAEA), Vienna. Gamma Standard sources includes: Caesium-137 and Cobalt-60; also, calibration energy of 661.60 keV for Cs-137 or 1173.2, 1332.5 keV for Co-60 was used. The 1764 keV γ line of ^{214}B for U was used in the assessment of the activity concentration of ^{226}Ra, while 2614.5 keV γ-line of ^{208}Tl was used for ^{232}Th. The single 1460 keV γ-line of ^{40}K was used in its content evaluation.

The samples were mounted on the detector surface and each counted for 29,000 s in reproducible sample detector geometry. The configuration and geometry was maintained throughout the analysis.

RESULTS AND DISCUSSION

Activity concentration estimation

All the obtained raw data were converted to conventional units using calibration factors to determine the activity concentration of ^{40}K, ^{226}Ra and ^{232}Th. The radioactivity concentration in the investigated samples was obtained as follows (Abel-Ghany et al., 2009).

$$A = (CPS)_{net}/I \times Eff \times M \quad (1)$$

where A is the activity concentration in Bq/kg, (cps) net is

Table 2. Activity concentrations of poultry feedstuff (Bq/kg).

Sample No.	Brand of feed	^{40}K	^{226}Ra	^{232}Th
1	Feed supplement	103.5±7.0	7.6±4.8	11.7±1.5
2	Feed supplement	134.6±3.6	14.5±0.3	12.1±1.5
3	Feed supplement	43.6±4.7	14.9±2.6	10.9±1.9
4	Feed supplement	168.3±5.2	19.6±0.7	0.9±0.3
5	Feed supplement	131.5±5.8	12.2±1.4	11.6±0.3
6	Compounded feed (Rebson feed)	179.8±4.7	19.2±2.2	23.6±1.4
7	Compounded feed (Rebson feed)	48.7±3.9	9.4±1.5	22.3±0.8
8	Compounded feed (PLS)	160.7±5.6	34.7±2.2	49.6±1.9
9	Compounded feed (PLS)	178.7±2.9	7.6±3.3	37.1±7.9
10	Compounded feed (PLS)	196.8±7.2	5.0±0.3	51.6±1.4

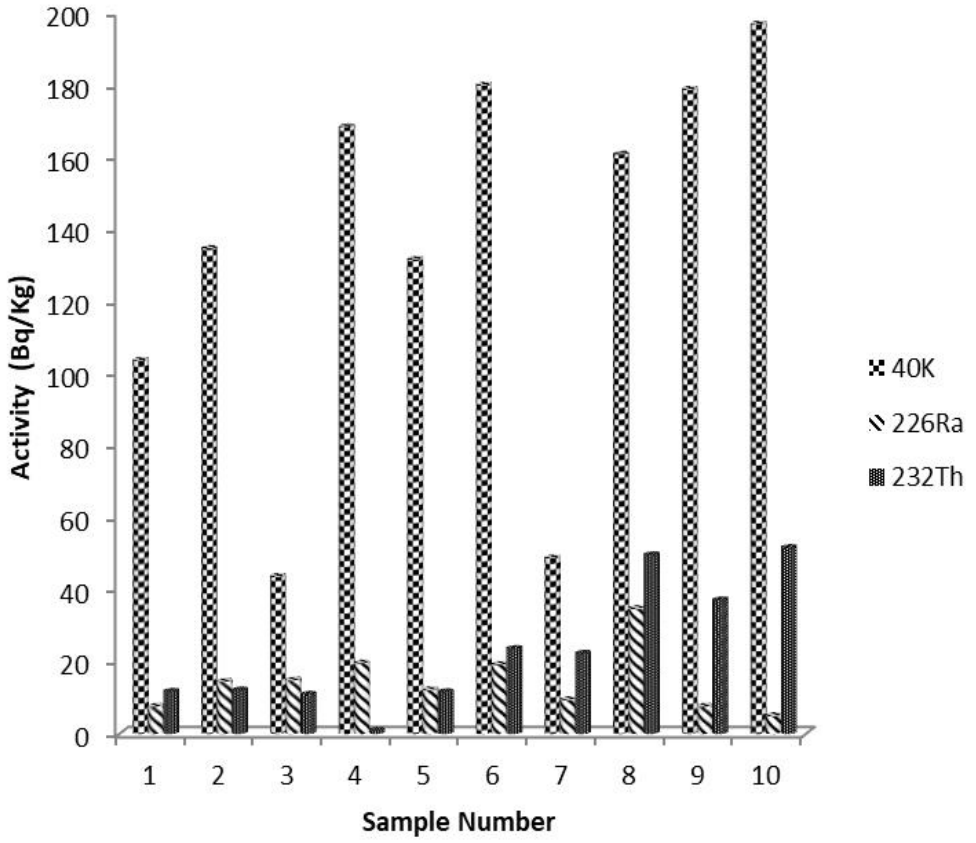

Figure 1. Activity concentration of K-40, Ra-226 and Th-232.

the count per second and equals cps sample-(cps) background. I is the intensity of the γ-line in a radionuclide, E_{ff} is the measured efficiency for each γ-line observed and m is the mass of the sample in kilograms. The quantity $I \times E_{ff} \times m$ is called the conversion factor. The conversion factor for the conversion to Bq/kg for each radionuclide is given thus; K-40 = 0.000643, Ra-226 = 0.000863 and Th-232 = 0.000877.

The activity concentrations of ^{40}K, ^{226}Ra and ^{232}Th were estimated and shown in Table 2 and Figure 1. The results showed that the activity concentrations in feed supplement range from 43.6 to 168.3 Bq/kg for ^{40}K, 7.6 to 19.6 Bq/kg for ^{226}Ra and 0.9 to 12.1 Bq/kg for ^{232}Th, while that of the compounded feed range from 48.7 to 196.8 Bq/kg for ^{40}K, 5.0 to 34.7 Bq/kg for ^{226}Ra, and 22.3 to 51.6 Bq/kg for ^{232}Th. Methionine and layers premix of the

Table 3. Comparison of activity concentration (Bq/kg) of poultry feeds in different locations.

Country	References	^{226}Ra	^{232}Th	^{40}K
Egypt	Harb et al. (2010)	0.35-1.17	0.27-1.07	60.51-91.21
Korea	Choi et al. (2008)	0.026	0.0127	58.5
Brazil	Filho et al. (2016)	0.23-1.51	0.29-1.63	236-402
Nigeria*	Present work	5.0-34.7	22.4-51. 6	48.7-196.8

*****Present research work.

feed supplements had higher values of ^{226}Ra and ^{40}K compared to the other supplements, while chick mash and the two samples of compounded layers mash had higher values of ^{226}Ra and ^{232}Th.

Generally, the compounded feeds had higher values than the feed supplements which is expected, since some of these supplements are used for compounding feeds. The activities' concentrations of ^{226}Ra and ^{232}Th obtained for Nigerian compounded feedstuff shown in Table 3 are relatively higher compared to those of Egyptian, Korean and Brazilian feedstuffs (Harb et al., 2010; Choi et al., 2008; Filho et al., 2016). The presence of anthropogenic radionuclides was not detected which shows that there was no contamination due to artificial radionuclides.

Conclusion

In this study, the activity concentrations of natural radionuclides, ^{40}K, ^{226}Ra and ^{232}Th in different samples of Nigerian poultry feed supplements and compounded feeds were estimated. The results were also compared with other poultry fodders in other parts of the world. Although, the Nigerian poultry fodders had relatively higher activities of ^{226}Ra and ^{232}Th, the radionuclide concentrations are not alarming. By implication, a transfer of such levels to chicken and finally to human in the radionuclide pathway will pose no danger when poultry products of meat and eggs fed from these feeds are consumed eventually by the public.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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